Agriculture: Critics Find Basic Research Stunted and Wilting

The basic research performed by federal and state agricultural research organizations is of meager quality, suffers from a "shocking lack of intellectual leadership," and is guided by policies detrimental to the interests of agriculture. This is the opinion of a number of well-known academic scientists who studied the agricultural research enterprise under the auspices of the National Academy of Sciences (NAS). Administrators in the Department of Agriculture (USDA) do not accept their conclusions but have not come up with a point-by-point rebuttal. Agricultural scientists have not yet had an opportunity to respond to the academy's criticisms because the report, although completed nearly a year ago, has been restricted to top administrative levels within the USDA (it is now available to the public*).

The academy report is the work of a blue-ribbon committee of basic and agricultural scientists chaired by Glenn S. Pound, dean of the College of Agriculture at the University of Wisconsin. In its main report (summarized in *Science*, 5 January), the committee faulted the agricultural research establishment for supporting pedestrian and inefficient work, for neglecting basic research, for poor coordination between the federal and state systems, for inept management of scientists, for grossly inadequate programs of staff improvement, and for administrative philosophies repressive to the vitality of scientists. The list of charges, resembling in completeness that brought against the last of the Avignon popes, is partly based on a series of studies made by panels of the committee and published as appendices to the main report. This article discusses the panel surveys of basic biological research. Other articles will consider the panel reports on forest, environmental and sociological research, and the agricultural research enterprise in general.

The panel reports on basic research are addressed to the 200 or so laboratories of the USDA's Agricultural Research Service (ARS), as well as to the state agricultural experiment stations (SAES) in each state of the union. "The present health of agriculture-related biochemical research is not only poor, but deteriorating. . . . Basic research is supported poorly in most agricultural research units, and is actually discouraged in many USDA units surveyed, even when it is clearly related to the unit's research mission," concludes the NAS panel on biochemistry. Authors of the panel report are Harlyn O. Halvorson of Brandeis University and Robert W. Holley of the Salk Institute. (Holley formerly worked in an ARS laboratory at Cornell where he did his Nobel-prize-winning study of transfer RNA.)

Appalling Lack of Support

According to Halvorson and Holley, the USDA has relied on other government agencies to support most basic research relevant to agriculture. For example, a survey of the American Society of Plant Physiologists in 1969 showed that members received less than 10 percent of their funds from the USDA. Since then other government agencies have retrenched on their support of the plant sciences, but are still largely responsible for what strength remains in biochemical research related to agriculture. Although outstanding basic research is conducted in some USDA labs, agriculture has been neglecting its responsibilities even in fundamental problems of primary concern to its mission, such as photosynthesis and nitrogen fixation. The panel looked closely at these two fields and, in the case of photosynthesis particularly, was "appalled at the lack of support by administrators who have responsibility for agricultural research."

Basic work on photosynthesis, the panel asserts, is "almost without exception carried on in private and state universities and research institutions, without support from the USDA. . . . At present one is reasonably safe in asserting that not one of the nation's outstanding leaders in photosynthesis works in a USDA laboratory and that not one receives his major support from USDA funds." (It should be noted that the panel explicitly excludes from its definition of photosynthesis work relating to overall crop yields and the effects of pollutants, areas in which the USDA and state contribution is admitted to be appreciable.)

The panel cites the following evidence for its statement:

► Of 56 papers on photosynthesis presented by U.S. participants at the 1969 International Botanical Congress, only two acknowledge support from the USDA.

► Of a list of ten full-time USDA workers on photosynthesis furnished by a well-known professor in a leading college of agriculture, the names of only three were even recognized by the editor of *Plant Physiology*.

► Of the 35 reviews of photosynthesis published in *Annual Review of Plant Physiology* since 1950, not one was written by a USDA scientist, and only six were written by scientists associated in some way with state experiment stations.

► A review of 136 state and USDA research projects in photosynthesis was conducted by another NAS panel, chaired by Kenneth V. Thimann of the University of California, Santa Cruz. On the basis of computerized summaries of the project (known as CRIS reports, and roughly equivalent to an abstract) the Thimann panel graded the projects on the same scale as is used by National Institutes of Health and National Science Foundation in assessing grant applications. Only the top third of the projects fell in the range (1.0 to 3.0) that would have received funding from the NSF. The panel notes that "had the proposals been subject to review by peers . . . large sums of money would have been saved." Most of the top 10 percent of the projects were carried out at Cornell University and the University of Connecticut.

The Halvorson-Holley panel concludes that those responsible for research administration in agriculture have "minimized the importance of photosynthesis," which the panel considers to constitute a "shocking lack of intellectual leadership."

Turning to nitrogen fixation, the panel's method has been to identify eight substantial advances made in understanding nitrogen fixation in the last 20 years, together with the source of support on which the advances were made. The sources include the NIH, NSF, chemical industry, and others. State ex-

* *Report of the Committee Advisory to the U.S. Department of Agriculture* (National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22151), PE 21338 (main report) $4.85; PE 21339 (appendices) $9.00.

periment stations contributed toward five of the advances, the USDA to none (except insofar as it provides general support to experimental stations). The panel blames the USDA for providing only token support of research on nitrogen fixation and for having shared in none of the substantial advances in the subject over the last 40 (*sic*) years.

A separate panel report, written by Halvorson, examines the extent of support of molecular biology by agricultural institutions. Following the same procedure used by the Thimann panel to assess work on photosynthesis, Halvorson rated 139 state and federal agricultural projects on the basis of the CRIS reports in the USDA's computerized information system. The projects were rated on the scale used in the NSF/NIH peer review system (1 counts high, 5 low). Halvorson notes that since the NSF and NIH rarely approve molecular biology proposals ranking below 2.0, none of the projects supported by the USDA or by the USDA and others would have been funded by these agencies (see Table 1). The few projects that would have been funded accounted for only $133,000 of the $3,700,000 expended on all 139 projects.

As another measure of the agricultural effort, Halvorson analyzed the source of support of all the articles that appeared in the *Journal of Molecular Biology*, one of the leading journals in the field, during 1970. None of the authors was supported by USDA funds and only two received some support from state agricultural stations.

USDA-supported projects in molecular biology are of consistently lower quality and higher cost than those funded by other agencies, Halvorson concludes. He finds it distressing that important problems in molecular biology, such as plant viruses, plant meiosis, and nucleic acid synthesis in seeds, are supported by nonagricultural sources, which are now drying up.

How accurate are the academy panels' judgments? Do they tell the whole story, or are their conclusions designed to prove a particular point? The report of the Pound committee was reviewed by the top level group that coordinates federal and state research, the Agricultural Research Policy Advisory Committee (ARPAC), but the ARPAC reviewers did not feel it "appropriate" to attempt a detailed critique of the report. "There is no point in our going back and feuding with them," said one USDA official.

Table 1. Quality of USDA/SAES projects in molecular biology.

Rating	USDA		USDA + others		State stations and others	
	No.	%	No.	%	No.	%
1.0 to 1.9	0	0	0	0	5	8
2.0 to 2.9	2	7	14	29	33	52
3.0 to 3.9	16	60	29	59	20	32
4.0 to 4.0	9	33	6	12	5	8

A general criticism voiced by ARPAC and every USDA official asked to comment on the report is that it was unfair to judge the quality of agricultural research on the basis of the CRIS system reports. The CRIS reports are abstracts of not more than 500 words or so, whereas grant applications to the NSF and NIH are far more detailed.

Some USDA administrators see the Pound report as reflecting more on the adequacy of the CRIS system than anything else. Members of the Pound committee panels, on the other hand, say that the CRIS reports are an adequate even if not ideal basis for judgment. "Even in an abstract, if you have anything original it clearly appears. I don't think that is a valid defense," says Thimann. Even if an individual project cannot fairly be judged on the basis of a 500-word abstract, the point at issue is whether a panel of experts can make assessments of this kind which are true on average. Nor were the CRIS reports the only yardstick of research quality.

Pound Committee Self-Serving

Another general criticism of the Pound report is that its attack on the USDA/SAES's basic research was self-serving. "It appears that the prime movers of the NAS study were motivated by trying to get more extramural funds [grants awarded by the USDA to universities]," comments Hugo O. Graumann, assistant administrator of the ARS for plant and entomological sciences. "Here you had a group of scientists whose support from the NIH and NSF for their so-called basic research had dried up. They sent their proposals to Agriculture and were shocked to find we couldn't fund them." The Pound report certainly makes no secret of its belief that the USDA should shoulder the burden of supporting basic research in plant sciences that other agencies have dropped, and explicitly recommends that the USDA should devote 10 percent of its total research budget to extramural grants for basic research. This viewpoint could perhaps have tinged some of the committee panels' assessments, but that it might have made a major difference to the report seems less certain.

Evident from discussions of the report with USDA officials is that their definition of basic research and that of the Pound committee do not have a great deal in common. Administrators argue that ample basic research—much of which the Pound committee failed to detect—is conducted as part of the research devoted to the various crop plants. Between 30 and 40 percent of the budget of the ARS Division of Plant Sciences was devoted to basic research, says Graumann, the director of the division until its abolition in last year's reorganization of the ARS.

Some ARS officials tend to distinguish between basic research and what they call academic research. According to this view, scientists at Harvard and Yale have spent thousands of dollars from the NSF on photosynthesis research, none of which could be translated into more efficient crop production; nor is there much point in sending ARS scientists to the international congresses where such results are discussed because the same kinds of things are being said there now as were said 20 years ago.

This viewpoint is to some extent shared by one of the few agricultural scientists whom Pound committee members would accept as a distinguished basic researcher, Sterling B. Hendricks. Hendricks, now retired from the ARS laboratory at Beltsville, Maryland, believes it is doubtful, odd as it may seem, that knowledge of photosynthesis has really been useful in agriculture to date, although it may be in the future. The question which the Pound committee neglected, in his view, is whether the basic research of the ARS is good for agriculture, not whether it satisfies academic criteria such as publication lists. Whatever the immediate relevance of photosynthesis, the Pound committee position is that it is "kind of ridiculous," in one member's words, for the major government organization dealing with plant growth not to be supporting good basic work in the subject.

The USDA believes it is doing just that. Asked to comment on the Halvorson-Holley panel statement that the USDA supports none of the country's leading researchers in photosynthesis, a senior ARS plant physiologist cited

the names of three ARS scientists doing outstanding work. A panel member agreed, on being queried about these names, that two of them were first-rate scientists (he had not heard of the third) but said they were studying factors that affect photosynthesis rather than the process itself. "If the USDA could only produce two shining stars, this is a pretty poor showing—we could show as many good people in a single department," this member added.

The size of the USDA's efforts on basic plant science research is hard to assess. The ARS has 170 plant physiologists on its payrolls (reduced from 188 a few years ago). Estimates of the number working on photosynthesis range from 12 to 20 scientists. Assuming for the moment that the Pound committee is correct in asserting that basic science has been neglected, how could such a situation have come about? Several possible contributory factors can be identified.

First, until last year's reorganization, and to some extent even now, the ARS was organized along commodity lines with an administrator known as the branch chief responsible for each crop. The branch chiefs, who in effect made most of the decisions on research programs, tended to look for short term results of immediate relevance to their own crop. Basic research was "pie-in-the-sky" for some branch chiefs, says an ARS plant physiologist. He adds that other chiefs were aware of the need for a good basic research program and would have created one, had it not been for the restrictions on funds and on hiring that have been placed on the ARS during the last few years.

Second, there seems to have been no one above the level of branch chief in the old ARS organization to stand up for the importance of basic research. Graumann, the former director of the plant sciences division, indicates that the impetus for basic research had to come from the scientists at the bottom, not the administrators at the top. "ARS administrators make no attempt to encourage or discourage basic research," he told *Science*. "This is left to the basic scientists. The administrators are concerned with fulfilling broad missions, basic and applied, such as improving the production efficiency of corn or oats. At no time did I bother myself with whether scientist Smith should do basic research in the area of photosynthesis. We didn't say so much should be reserved for research on photosynthesis or nitrogen fixation. We assumed the scientists at the bench level who were working with this kind of thing would, in counsel with their branch chiefs, see the critical needs to which they should address themselves." Asked what kind of scientific decisions an administrator would make, Graumann replied, "He doesn't, other than making sure we have a proper balance of scientists to accomplish our missions."

What kind of opportunity is there for ARS scientists to do basic research? Administrators say there is ample opportunity, and point with pride and some pain to the instance of Holley. Holley, however, is not a good witness for their argument. "There is the freedom within the system to support basic research," he told *Science*, "but it just isn't used. The reason it worked for me was that the director of my lab, W. H. Allaway, thought my work was important and gave me the support

Briefing

Congress Picks Up Technology Gauntlet

Since the expulsion of the science advisory apparatus from the White House, Congress has become the focus of a considerable amount of recent buzzing and humming about science—or, more accurately, about those aspects of technology which have national implications.

In late March, the powerful Senate Commerce Committee invented a new subcommittee on Science, Technology and Commerce with Senator John V. Tunney (D–Calif.) as its chairman. The committee will oversee science and technology activities in the Commerce Department. Its staff coordinator explained that, with the White House science office gone, the Assistant Secretary of Commerce for Science and Technology, a post just filled by Betsy Ancker-Johnson, a physicist formerly with the Boeing Co., has become "one of the two highest ranking science officials in government."

The new subcommittee will look first into energy conservation and regulation, including a Tunney bill to fund research on low-polluting auto engine alternatives. Then, later this spring, it will delve into a subject little studied by Congress: science and innovation as it relates to national productivity, and the apparent decline in national trade posture in high technology products.

Tunney is one of Edward M. Kennedy's (D–Mass.) closest friends in the Senate, and the arrival of a technology subcommittee under him has obvious implications in extending Kennedy's reach. Staffers on both sides indicate the two will work "hand in glove," which could mean a Mutt-and-Jeff style act with Kennedy, through oversight of the National Science Foundation, looking into basic academic research and Tunney, through the Commerce subgroup, tracking technology and trade. This duo will obviously carry one step further when in the summer the Office of Technology Assessment, of which Kennedy is chairman of the board, is established.

In the House Mike McCormack (D–Wash.), although only starting his second term in Congress, was just made chairman of a subcommittee on energy of the Committee on Science Astronautics, which of itself is something of a feat. Among McCormack's other achievements (he is a scientist by training) are a completed study of energy research policy—of which all 1700 copies were gone within a week—and a new seat on the Joint Committee on Atomic Energy. With the emergence of McCormack and Tunney, it would seem that science—or rather technology—has acquired two new lieutenants in Congress.

—D.S.

Pauling, Wald Support Shell Strike

A group of 29 scientists has joined the list of 11 environmental groups already supporting the 3-month-old strike of the Oil, Chemical and Atomic Workers (OCAW) union against the Shell Oil Company (see *Science*, 13 April 1973). Nobel prize winners Linus Pauling and George Wald, as well as environmental expert Barry Commoner, were among the signers of a statement that termed the success of the strike as "critical" and called American workers "unwitting 'guinea pigs'" in past re-

to do it full time. The previous director had thought it was worth half my time. But for Allaway, I would not have finished the structure [of the yeast alanine transfer RNA molecule] before someone else did and I would not have gotten the Nobel prize." Holley adds that, in his view, "Few administrators in ARS have the foresight to support basic research, because they don't recognize its importance for their own mission."

Besides the luck of the draw in the attitude of their administrator, another kind of restriction on "bench scientists," as scientists are referred to in the ARS, is the unwritten rule that they must conduct their research on the crop plant for which their funds are earmarked, whether or not it is the most suitable organism for the purpose. Even Hendricks, who headed a lab specially assigned to do basic research, set himself the limitation of always working on seed plants. ARS scientists say this restriction has eased somewhat since the reorganization last year, but H. R. Carns, chairman of the newly created Plant Physiology Institute at Beltsville, told *Science* that "If money has been appropriated for tobacco, then people funded by it are fairly well limited to working with tobacco. They may use other plants to supplement their work but only to supplement it." Scientists could work on *Chlorella* (an alga frequently used for basic studies of plant biochemistry) but it would require "careful assessment," Carns said. No one at the Plant Physiology Institute is working on *Chlorella* at present. Asked how serious a handicap restriction to a crop plant might be, the editor of *Plant Physiology*, Martin Gibbs, rated it as 'serious to quite serious.' "If you are trying to get to the basic cellular level, crop plants are not necessarily the organisms I would select. But with ingenuity you can get round this, providing that you have people who can devote the time and effort to doing so," Gibbs said.

With administrators leaving research decisions pretty much to the branch chiefs, the branch chiefs having an immediate duty to solve the short term problems of their particular crop, and the "bench scientists" ruled by their particular branch chief's attitude toward basic research, it is possible to see in principle how a strong fundamental research effort of the type advocated by the Pound committee could have failed to flourish within the ARS administrative system. A similar predominance of short term needs seems to have prevailed in the state agricultural experiment stations, although it is tempered by their responsibility for training researchers.

Even assuming the Pound committee is largely correct in saying that the federal and state basic research effort is poor and needs to be improved, that does not necessarily mean that the present activities are not in their own way of benefit to agriculture. Moreover, it is easier to change directions on an expanding budget, and for the last few years the ARS has been held on tight rein. In making its case for a better basic research effort, the Pound committee has said some things which are bound to hurt. Maybe understandably, administrators in the ARS seem more interested in stonewalling the committee's arguments than in addressing the issues they raise.

—NICHOLAS WADE

Briefing

searches into the medical hazards of environmental contaminants. The statement called on Shell to take a stand "more consistent with the public interest" by accepting OCAW's demand for a voice in health and safety issues. Through an innovative clause, OCAW seeks a joint labor-management committee with authority over health and safety issues, but Shell has maintained that these are its legal responsibility alone.

At a Washington press conference on 12 April, the convenor of the ad hoc group, Samuel S. Epstein, environmental toxicologist at the medical school at Case Western Reserve University, stressed that scientists have a stake in getting big companies like Shell to cooperate in examinations of the epidemiological and environmental hazards of most substances. The disputed contract clause, which has been accepted by more than 15 other companies, would open the way for such studies through the establishment of the joint labor-management committees.

Although the scientists signing the statement and represented at the press conference clearly all supported OCAW in the strike, it became apparent in the course of the questioning there that they had not taken a stand on related issues, such as a boycott of Shell products now under way. It was equally unclear whether the cosigners, as a group, would take any further action vis-à-vis the union or Shell.

Nonetheless, a union cosigner, Lorin Kerr, medical director of the United Mine Workers of America, saw advantages in having the prestigious scientists put forth such a statement. "For too long," he said, "occupational health has been isolated from the mainstream of public health. . . ." Kerr called on medical and environmental researchers to pay more attention to what he regards as an underrecognized, underfunded branch of medicine.—D.S.

John Burns a Candidate for Marston's Job at NIH

Serious candidates for Robert Marston's old job as director of the National Institutes of Health (NIH) apparently are being asked to fly to Florida to see President Nixon's friend Elmer Bobst as part of the screening process. In fact, many government scientists are saying that the Bobst interview is the one that counts most. As has been noted in this space previously, Theodore Cooper, director of the National Heart and Lung Institute and a leading contender for the job, has made the trip.

So, reportedly, has John J. Burns. Burns, a Ph.D. whose field is pharmacology, is vice president for research at Hoffmann-LaRoche, Inc., Nutley, New Jersey, one of the country's largest drug houses. Before taking a job with the pharmaceutical industry, Burns, who is well regarded by his scientific colleagues, worked for several years at NIH. Presumably, he would bring to the NIH a flair for business management that the Administration is looking for in its agency heads. Burns, a bachelor who reputedly works 20-hour days, is thought to have made a very favorable impression on Bobst, himself a former leader of the drug industry. Now well into retirement, the elderly Mr. Bobst is honorary chairman of the board of the Warner-Lambert Company.—B.J.C.